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# CHILDRENS EXPOSURE TO ΣDDT FROM DIFFERENT FOOD CATEGORIES

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## Introduction

Persistent organochlorine pesticides as DDT have been used intensely both as agriculture protection aids and for disease control for example for controlling malaria-carrying mosquitoes[1]. Even though the use of DDT has been prohibited for decades in most of the developed world, DDT and its metabolites slowly degradability and tendency to accumulate in fatty tissues they can enter the food chain and therefore be found especially in fatty food items e.g. fish, animal fat, eggs and milk. As a consequence of the intake of various fatty food items humans are exposed to DDT.

DDT (Dichlorodiphenyltrichloroethane) degrade mainly by dehydrochlorination to DDE (Dichloro-diphenyldichloroethylene) but may also degrade to DDD (Dichlorodiphenyldichloroethane). However in this study DDE was the main compound observed, and for most samples DDT and DDD was below the limit of detection. Therefore, when calculating the ΣDDT (the sum of *p,p'*-DDE, *p,p'*-DDD, *p,p'*-DDT and *o,p'*-DDT) results will be almost equal to the DDE content in the samples.

This paper presents intake estimates for DDT combining levels in food with consumption data in order to predict the contribution of DDT from various food groups. Furthermore, the study compares estimates for children and adults.

## Materials and Methods

*Samples*: Samples of egg, milk, cheese, animal fat and fish were sampled in the Danish food monitoring programme. In total 36 different food categories were monitored from 1998 to 2003 adding up to 3552 samples food samples. All samples were raw materials and not prepared, however for fish the edible part was defined as the fish meat without skin.
*Compounds*: All samples were analysed for their content of 10 PCB congeners and a number of organochlorine pesticides including *p,p'*-DDD, *p,p'*-DDE, *o,p'*-DDT and *p,p'*-DDT.
*Sample clean-up*: Fat was extracted from the samples and an part added to a Florisil column deactivated by water and eluted with dichloromethane:pentane (1:4). The eluate was carefully evaporated and the sample dissolved in isooctane. The final sample was analysed by gas chromatography using two different columns and electron capture detectors.
*GC-ECD parameters*: Perkin Elmer autosystem gas chromatograph. Column: 50 m CP-Sil-5CB (Chrompack) and 60 m DB-17 (J&W), 0.25 mm i.d., 0.25 µm film thickness. Carrier gas: Helium, 15 psi (CP-Sil-5CB) or 37 psi (DB-17). 2 µl injected splitless, splitless time 2.5 min. Injector held at 220 °C. Temperature programme: 90 °C for 1 min., 30 °C/min. to 180 °C in 10 min., 2 °C/min. to 240 °C, 10 °C/min. to 280 °C in 20 min. (CP-Sil-5CB) or 30 min. (DB-17). Detector temperature 320 °C. Organochlorine compounds were quantified by comparing responses with those of standard mixtures. Limits of detection for organochlorine pesticides were 0.5 to 4 µg/kg.

## Results and Discussion

Intake estimates are based on the dietary intake data collected in the Danish nationwide food consumption survey 2000-2002[2]. The food consumption data were sampled throughout the 3 years in order to take into account any possible seasonal variation in dietary habits. The representative sample of Danes included a total of 4120 respondents (2167 female and 1953 male) aged 4-75 yr. The Danish nationwide food consumption survey used a seven-day prospective food record with a pre-coded (semi-closed) questionnaire that included answering categories for the most commonly eaten foods and dishes in the Danish diet. The food amounts eaten were given in household measures, e.g. pieces, glasses, cups, spoons and by use of photos. These portion sizes were used in the conversion of the reported amounts to weight (grams). Composite foods (e.g. dishes) were split up into ingredients by means of standard recipes. Due to the simplified design of the questionnaire, the total diet could be represented by the intake of 333 food items. The final result of these conversions was then recalculated and expressed as the daily mean intake for the seven-day food register of each participant in the survey.

Based upon the individual's data, it was possible to describe the intake distribution of both foods and chemical contaminations for the population divided into children (4-14 years of age) and adults (15-75 years of age). For calculations of the intake of contaminants, the individual-level consumption of each of the food items was multiplied by a mean result of the contaminant content in that particular food item. The result of this is a distribution of the contaminant intake among children and adults. The bodyweight of the individual respondents was used in the intake calculations.

**Table 1. DDT-sum for selected food items**

| Foodstuff | Number of samples | Mean* ng/g** | Maximum ng/g** |
|---|---|---|---|
| Chicken fat | 197 | 2 | 17 |
| Turkey fat | 85 | 2 | 15 |
| Beef fat | 385 | 3 | 25 |
| Pork fat | 884 | 3 | 99 |
| Lamb sheep fat | 37 | 6 | 75 |
| Animal fats, other | 20 | 3 | 28 |
| Milk, Danish | 248 | 3 | 171 |
| Milk, foreign | 41 | 3 | 9 |
| Cheese, Danish | 40 | 3 | 15 |
| Cheese, foreign | 166 | 4 | 68 |
| Butter, Danish | 126 | 2 | 58 |
| Butter, foreign | 22 | 11 | 68 |
| Eggs | 280 | 1 | 10 |
| Cod, raw | 10 | 1 | 2 |
| Eel, farmed, raw | 130 | 61 | 175 |
| Herring, raw | 26 | 8 | 17 |
| Herring, pickled | 11 | 11 | 17 |
| Herring, smoked | 12 | 7 | 12 |
| Lumpsucker, raw | 11 | 15 | 22 |
| Mackerel, raw | 20 | 4 | 6 |
| Mackerel, smoked | 18 | 5 | 12 |
| Rainbow trout, farmed, raw | 273 | 5 | 28 |
| Salmon, raw | 20 | 15 | 71 |
| Trout, marine farmed, raw | 77 | 13 | 49 |
| Cod liver | 111 | 260 | 1,599 |
| Fish oil | 21 | 40 | 300 |
| Cod liver oil | 9 | 200 | 360 |

* mean is calculated including 1/3*d. for values below the detection limit.
** ng/g fish and egg and ng/g fat for the rest of the foods.

The monitoring study was planned with the intent of closely following all food items with either a high content of residues or high consumption, for example lean fish such as cod has appreciably lower contents of organochlorine pesticides than fat fish such as salmon, but the consumption of cod is relative high. Kidney fat from cattle and pigs and subcutaneous fat from poultry were analysed as studies[3,4,5,6] have shown that the contents of organochlorine pesticides in such fatty tissues are representative of the contents in the market meat when measured on the basis of fat. In animal fat, ΣDDT is detected at low levels in the majority of animal fat samples and at a higher level in fish samples. The majority of dairy products contain ΣDDT at low average levels except for Danish butter, where the compounds are only found in a few samples. Selected average contents of ΣDDT analysed in various foods are presented in Table 1.

For environmental contaminants such as DDT, it may be assumed that they occur everywhere in the environment and therefore in all fatty food of animal origin. The intake contribution from fruits and vegetables is not included in the intake calculations. The calculated average daily intakes for children and adults of ΣDDT are presented in Table 2. Furthermore, the 0.90 quantile and the 0.95 quantile for the daily intake are given. The intake of ΣDDT was calculated on the basis of the sum of average contents of the monitored *p,p'*-DDD, *p,p'*-DDE, *o,p'*-DDT and *p,p'*-DDT. The Danish average daily intake has been estimated to 6.7 ng/kg bodyweight/day and 3.7 ng/kg bodyweight/day for children and adults, respectively. Children's average intake of ΣDDT is twice as high as for adults, due to their high food consumption, compared to their bodyweight. Persons (children or adults) having a relatively high intake of the substances (the 0.90 quantile) are estimated to consume approximately twice as much, whereas persons with special intake patterns, e.g. a substantial consumption of cod liver or cod liver oil, may have even higher intakes.

**Table 2.** Calculated intakes as ng/kg bodyweight/day

| ΣDDT | Average intake | Intake, 0.90 quantile | Intake, 0.95 quantile |
|---|---|---|---|
| | (ng/kg/day) | (ng/kg/day) | (ng/kg/day) |
| Children | 6.7 | 12.5 | 15.7 |
| Adults | 3.7 | 6.5 | 8.4 |

Figure 1 shows the estimated contributions of individual food groups to the average daily intake of ΣDDT. The group of fats includes the contributions from composite products, butter, vegetable oil and cod liver oil. For ΣDDT, adults consume approximately 45% of the average daily intake though fish whereas fish only contributes to about 32 percent for children. In contrast only 11% of the ΣDDT intake for adults derives from milk whereas about twice as much (20%) of the ΣDDT intake for children derives from milk products, as children have a higher consumption of milk and milk products and a smaller consumption of fish compared to adults.

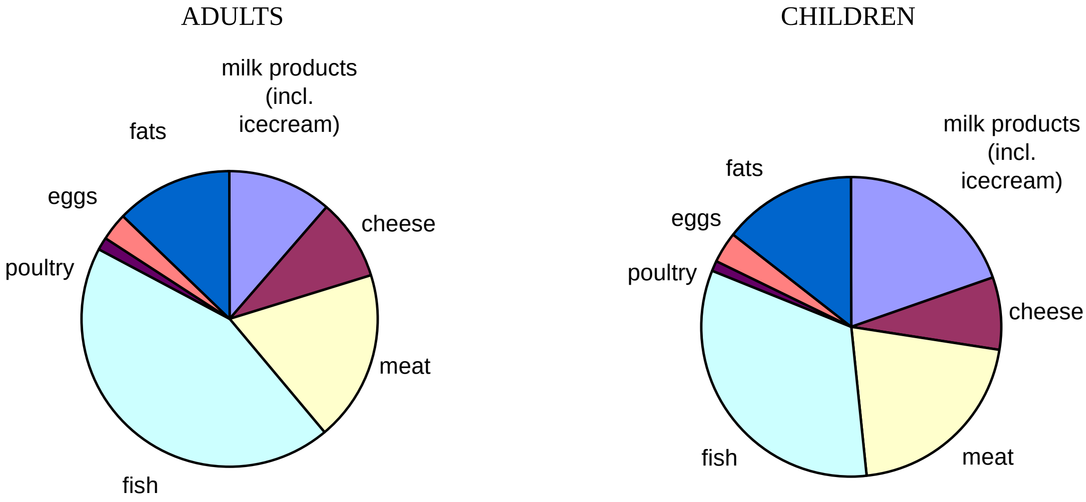


***Figure 1***. *Estimated contributions of various food groups to adults (left) and children (right) intake of ΣDDT.*

In order to get reliable intake estimates of the persistent organochlorine pesticide DDT and its metabolites in children and adults a larger number of foods have been analysed. As DDT and its metabolites are lipophilic compounds fatty food items e.g. fish, animal fat, eggs and milk have been analysed and combined with the consumption of the food items in order to estimate the intake. The estimated contributions from the various food groups to children and adults intake of DDT are very similar, however differences are observed as children has a higher part of their intake from milk products than adults and lower part of the intake from fish products than adults. The food group contributing most to both children's and adults intake of DDT and its metabolites is fish and fish products, whereas eggs and poultry contribute with the smallest part of the food groups investigated. The results demonstrate, however that average intake as well as the high intake of DDT is relatively low compared to the Tolerable Daily Intake (TDI).

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